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MADRAS RECORD OFFICE.

Government of Madras.

Public Works DEPARTMENT.

G.O. No. 2154 Press/Mis.

53-54

Dated 3-7- 1869.

Not to be folded or roughly handled

Proceedings of the Madras Government, Public Works Department, 3rd July 1869.

No. 53. Read the following Circular from the Government of India, Public Works Department, (Civil Works—Communications,) dated Simla, 12th May 1869, No. 33:—

Sir A. Cotton's plan for the construction of Steam-boat Canals, the water for lockage and evaporation being raised by steam-power.

Read the following papers:—

From Lieutenant-General Sir A. COTTON, R. E., Madras, to the Under Secretary of State for India, dated 23rd June 1868.

In 1858 I was ordered by the Government of India to proceed to Cuttack, to report upon the state of the Mahanuddee at that city, and the Lieutenant Governor of Bengal took the opportunity to obtain the authority of the Viceroy for my inspecting the country between the Hooghly and the main Ganges, in order to project a work for the constant communication by water on that line. The present direct communication by the three rivers, the Matabhanga, Jellinghee, and Bhagiruttee, being only available three months in the year on account of the insufficiency of the water in them when the Ganges is low; for the rest of the year, the steamers have to go down the Hooghly to the sea, and through the Sunderbunds to the Ganges, a detour of 300 miles.

I had the honour of furnishing the Governor of Bengal with a project for this purpose, the works consisting of a weir across the Ganges at Rajmahal, similar to those at Madras, with a canal for both irrigation and navigation, thence to Calcutta, 180 miles. This, I have no doubt, will be a most beneficial and highly remunerative work.

I understand a work of this kind is now under consideration.

But circumstances have lately arisen which have forced this question of navigation in Bengal upon me, and have led to the discovery of a mode of accomplishing this object of navigation alone so cheaply, that had it occurred to me at that time, I should have probably proposed a project of much smaller extent, and which it is extremely probable would have even then been carried out, as Lord Canning was Viceroy at that time.

This matter has been brought before me now by the late Report of the Orissa Irrigation Company, in which the extraordinary returns received on their navigable canals have shown the immense demands for such works, and their consequently highly remunerative character.

On their tidal canal, between the Hooghly and Midnapoor, they have now opened only about twenty-five miles, and of this only the first portion of eight miles was used to any extent, and though it was so short, and ended at no place of the smallest importance, there was a traffic of no less than 8,300 boats in the last half of last year, carrying 57,000 tons and 30,000 passengers, paying £736, or about £ 80 a mile, equal to £ 160 per annum, and as the first three months of 1868, the tolls were three times that of the corresponding period of 1867, so also on the twenty-six miles of canal leading towards Cuttack, and also ending at only a small town, and the work in a very incomplete state, the tolls were £ 946, or £ 36 a mile, equal to £ 72 per annum; while the previous year they were only £397. If there is such a traffic on such small portions of canal, not completing the communi-

cation with any important point, with such a rapid increase in a single year, it is certain that when these two lines are completed, the one to Midnapoor and the other to Cuttack, putting the whole Delta and the Upper Mahanuddee in direct communication with Calcutta, the tolls will be many times these amounts.

If the tolls are no less than £ 160 a mile on a small portion of the line to Midnapoor, and £ 72 a mile on the first twenty-six miles towards Cuttack already, and increasing 2½ and 3-fold in a single year, we may be certain that when these lines are completed, the tolls will be at least £ 300 or £ 400 a mile, which on the fifty miles of canal to Midnapoor, and the 250 to Cuttack, would be about £100,000, or 10 per cent. gross, an ample return on the whole present capital of the Company.

From this it seems certain that as they will have at least 500 miles of main canal when they have completed their first set of works, costing about £ 1,300,000, the navigation alone will provide a high interest independent of any irrigation returns.

But it is certain that the traffic on this side of Calcutta must be only one-fifth or one-tenth part of what there is on the other side leading to the main Ganges and the Berhampooter. The tonnage of the boats entering, and the same leaving the Circular Canal at Calcutta, was several years ago three million tons, and it must be rapidly increasing, and were there a constant communication with the Ganges by an effective steam-boat canal throughout the year, this alone would certainly add enormously to the traffic, so that we could not reckon upon less than two or three million tons and passengers per annum on such a line.

These great and astonishing results already obtained on the short canals of the Company, have led me to re-examine the whole subject of water communication in Bengal, and this is what has led to a most important discovery in the matter in a point which entirely escaped my notice when I was ordered upon that duty in 1853. At that time it never occurred to me to calculate *what would be the cost of raising water by steam-power to re-place that lost by lockage and evaporation in a canal carried upon a high level.* But I have now done this, and find that the cost is altogether insignificant, so that a canal may be carried upon any level that will give the least possible excavation.

I have, therefore, now the honour of submitting the accompanying Memorandum on this subject.

This investigation shows conclusively that canals may be cut in any direction in Bengal at a cost quite trifling, fitted for large steamers, and at any speed, at about £ 500 or £ 600 a mile. And not only in Bengal, but as the cost of raising the water is so small, that even a lift of 50 feet would be no obstacle, such canals might be cut on any part of the Plains of the Ganges, or in other tracts of India, each individual canal of 30, 50, or 100 miles connecting important points, being a complete project in itself, quite independent of any extended scheme. This puts the whole question of steam-boat communication over a great part of India on an entirely new footing as most important lines *might be opened in a few months,* costing from £ 10,000 to £ 50,000 each, paying any interest that might be required. For instance, had this point occurred to me in 1859, I should probably

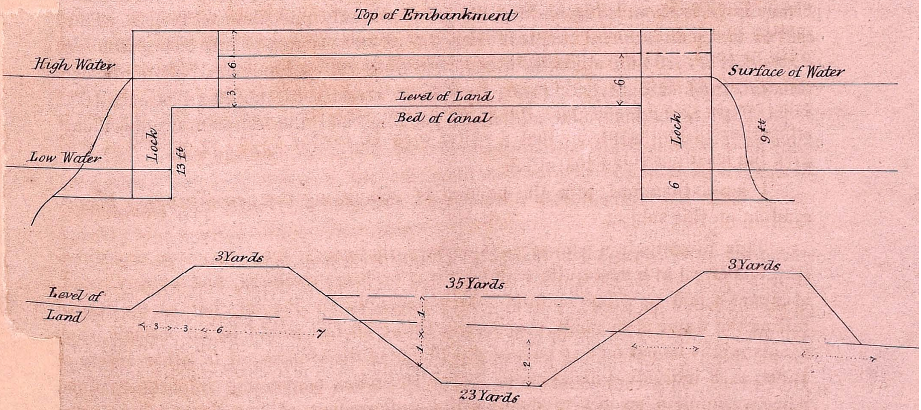
have proposed a simple work of this sort from Calcutta to a point in the direction of the main Ganges, where it would meet a branch river that is always open a distance of 100 miles, costing at most £ 50,000, which could have been cut by 10,000 men in about six months, conveying a traffic of at least two million tons, and yielding, at a toll of one-eighth pence per mile, £ 2,000 a mile per annum.

I therefore beg to submit this plan for steam-boat canals as worthy of thorough consideration.

Memorandum by Lieutenant-General Sir A. COTTON, R. E., Madras, on proposed canals for Bengal on a high level, the water for lockage and evaporation being raised by steam-power.

THE fundamental question with respect to navigation canals in Bengal, and, indeed, throughout the Plains of the Ganges, and in other Plains of India, is *what is the cost of re-placing the water consumed in lockage and evaporation by raising it by steam-power?* If this cost is found to be insignificant, then, instead of a deep cutting for the canal in order to be able to admit water from the river or creek, it will only be necessary to cut a single yard, or so deep just to obtain earth enough to form an embankment on each side, so as to give a sufficient depth of water, part of the water being below the level of the surface of the ground, and part above it, and the excavation will be simply in dry earth, and the quantity for a broad canal very small.

The longitudinal and cross-section of the canal might be then as shown here—



Excavation banks $7\frac{1}{2}$ yards × 2 × 2 = 30 yards; 30 × 1,760 = 53,000 cubic yards, @ $1\frac{1}{2}d.$, = £ 330 per mile.

This would give a canal 35 yards broad at the top, and 23 yards at the bottom

In such a canal the water in it would be $4\frac{1}{2}$ feet above high-water, and $13\frac{1}{2}$ above low-water, or the average lift, if the engine was worked throughout the day, 9 feet. If the locks were 150 feet long, 15 feet broad, with an average lift of 9 feet, the contents would be 750 cubic yards of water, weighing at 1,700 ℔s. per cubic yard, about $1\frac{3}{4}$ million ℔s. to be raised 9 feet, = $13\frac{1}{2}$ millions 1 foot, or about 8 Indicator H. P. 1 hour, or three nominal H. P. 1 hour; and the cost would be at 3 ℔s. of coal per I. H. P. at Rupees 10 per ton, $\frac{1}{3}$*d.*, or adding for management, &c., about half per I. H. P. per hour. This would give 4*d.* per lockfull. Locks of this size would pass boats of at least 200 tons, and if the canal were 50 miles long from one creek to another, 10,000 tons would be carried 1 mile for every lockfull, so that the cost for supplying the lockage would be $\frac{1}{2500}$*d.* per ton per mile, in fact, insignificant.

On the same canal the evaporation allowing 2 yards per annum, or $\frac{1}{5}$ inch per day above rain-fall, would be 1,760 yards × 2 yards × 35 yards × 50 miles × 1,700 ℔s. = 10,500 millions ℔s. to be raised 9 feet, = 95,000 million ℔s. 1 foot = 60,000 I. H. P. 1 hour, costing @ $\frac{1}{2}$*d.* per I. H. P. £ 125 per annum, and if the traffic were 1 million tons, and passengers a year, equal to 50 millions through 1 mile, the cost of supplying water for evaporation would be $\frac{£125}{50 \text{ millions}} = \frac{1}{1700}$*d.* per ton and per passenger per mile.

This also would be quite insignificant, the two together being only $\frac{1}{1000}$*d.*

We arrive, therefore, at this remarkable conclusion, that the cost of raising the water is in effect nothing, leaving us to cut the canal on any level that will give a minimum excavation. And even if the water had to be raised 50 feet out of deep rivers or wells, it would still be only $\frac{1}{230}$*d.* per ton per mile.

It may be asked,—but what absorption? To this I reply that, in these alluvial soils, there would be none at all; but even if it were very considerable and permanently so, even an inch a day, it would still only raise the cost to $\frac{1}{400}$*d.* The cost of locks on such a canal would be, at £ 200 per foot of lift, $13\frac{1}{2} \times 200 =$ £ 2,700, or £ 5,400 for one at each end, adding £ 100 per mile. If we allow 50 yards of aqueduct for crossing small creeks or streams in the 50 miles at £ 100 per yard of length, this would add £ 100 per mile, and the estimate would then be per mile—

	£
Excavation	330
Locks	110
Aqueduct	100

or £ 540 a mile for a canal 35 yards broad and 2 yards deep.

The cost of engine-power and apparatus would be trifling, as an engine of 10 nominal H. P. working by day only would be sufficient, costing about £ 500 or £ 20 per mile. Such an engine would take about a month to fill the canal in the first instance, but the canal would be available of course as soon as it had 2 or 3 feet of water in it.

The returns on such a canal on an important line in the neighbourhood of Calcutta, allowing only 1 million tons and passengers, or 500,000 of the former at $\frac{1}{8}$*d.*, and the same of the latter (1,600 passengers per day) at $\frac{1}{16}$*d.*, would be £ 380 per annum, or 65 per cent. on £ 560 a mile. But on the main line con-

necting Calcutta with the Ganges, the traffic would be at least 2 millions for the tonnage of boats alone entering the Circular Canal, several years ago was 3 millions tons, and of course the some boats left it, and this is besides all that discharged and loaded in the Hooghly.

And this plan is equally applicable to the upper plains of Ganges, because the cost of raising is so small, that even the ground is 40 feet above the summer level of the river, it would still be an insignificant item.

To make a navigable canal to be supplied from the river in such a case, without raising the water, would involve a weir, which would be a heavy work, and would, perhaps, take two years to build where the river is wide, besides heavy cutting at the head of canal; but if the water is raised, the canal would be formed as near the sea, by a simple cutting of a yard or so deep. Thus a straight steam-boat canal might be substituted for the winding river with its strong current in the monsoon, and its shallows in the dry season from Allahabad to Benares, reducing the cost of transit to quite a nominal sum, and the time, from several days as it often is in the dry season, to a few hours.

This line of 80 miles would involve about 100 feet of lockage in all, at £200 a foot, or £20,000, and 50 nominal H. P. of engine costing about £2,500, or with £350 per mile for excavation, about £650 per mile in all. The toll required to pay the interest of this capital at 7 per cent., including repairs, would be $\frac{1}{5}$*d.* on only 90,000 tons a year, and a million tons would yield a return of £ 500 a mile, 80 per cent. with that toll.

These plain calculations seem quite sufficient to show the great importance of this point, and the wonderful opening it makes for providing steam-boat navigation over a great part of India at a trifling cost in a very short time, and with very great money returns; a single million would probably provide 2,000 miles of first class steam-boat canal, yielding at least half a million a year, and the works might easily be executed in a single year.

On any line in which so wide a canal as the above sections show was not required, a considerably less section and excavation would be sufficient, as it might be made deeper and narrower, and the embankments low; for instance, 1½ yard of the depth of water might be carried below the surface of the land, and of ½ yard above, making the embankments only 1½ yard high, with a section of only 9 square yards each, costing only £ 200 a mile for excavation.

Observations.—The Governor-General in Council is disposed to mistrust the sufficiency of Sir Arthur Cotton's estimate, not only as to first cost of excavation of the canal and provision of locks, but also as to probable cost of pumping, and amount of traffic and consequent returns.

2. His Excellency in Council considers, however, that it may be useful to circulate the papers to the various Local Governments and Administrations, with a request that when any project is under consideration, and of which the conditions may be similar to those described by Sir Arthur Cotton, the Executive Engineer may be directed to ascertain to what extent the system can be applied with advantage to that particular case, the data on which the conclusions are drawn in favour of the ordinary or proposed system being fully explained.

Proceedings of the Madras Government, Public Works Department,
3rd July 1869.

ORDER.—Ordered, that copies of this Resolution be forwarded to the Local Governments and Administrations marginally noted, for information and guidance.

Governments of Madras, Bombay, Bengal, North-Western Provinces, and the Punjab.
Chief Commissioners, Oudh, British Burmah, Central Provinces, Mysore and Coorg.
Resident at Hyderabad.
Agents to the Governor-General for Central India and Rajpootana.

(Signed) R. STRACHEY, Colonel, R. E.,
Offg. Secy. to the Govt. of India.

No. 54. ORDER THEREON, 3rd July 1869, No. 2,154.

CIVIL WORKS, No. 10.

COMMUNICATED to the Superintending Engineers for information and guidance.

(True Extract.)

Colonel, R. E.,
Secretary to Government.

To the Chief Engineer for Irrigation.
To Superintending Engineers.
To the Officer in charge of Operations in Wynaad.

Exd. S. T. Augustin.

(7)

CIRCULAR No. 33 PUBLIC WORKS.

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

CIVIL WORKS.

Communications.

SIMLA, MAY 12, 1869.

Sir A. Cotton's plan for the construction of Steam-boat Canals, the water for lockage and evaporation being raised by steam-power.

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Dated 23rd June, 1868.

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To—Under Secretary of State for India.

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On their tidal canal between the Hooghly and Midnapoor, they have now opened only about 25 miles, and of this only the first portion of 8 miles was used to any extent, and though it was so short, and ended at no place of the smallest importance, there was a traffic of no less than 8,300 boats in the last-half of last year, carrying 57,000 tons and 30,000 passengers, paying £736, or about £80 a mile, equal to £160 per annum, and as the first three months of 1868, the tolls were three times that of the corresponding period of 1867, so also on the 26 miles of canal leading towards Cuttack, and also ending at only a small town, and the work in a very incomplete state, the tolls were £946, or £36 a mile, equal to £72 per annum; while the previous year they were only £397. If there is such a traffic on such small portions of canal, not completing the communication with any important point, with such a rapid increase in a single year, it is certain that when these two lines are completed, the one to Midnapoor, and the other to Cuttack, putting the whole Delta and the Upper Mahanuddee in direct communication with Calcutta, the tolls will be many times these amounts.

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Dated 22nd June, 1868.

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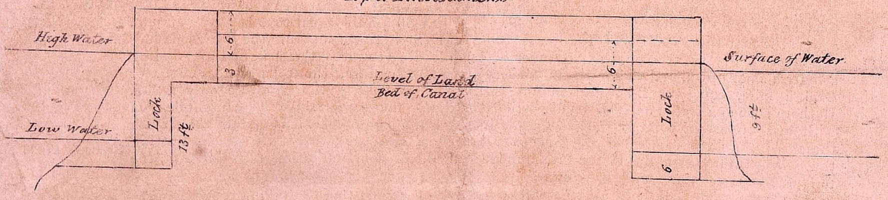
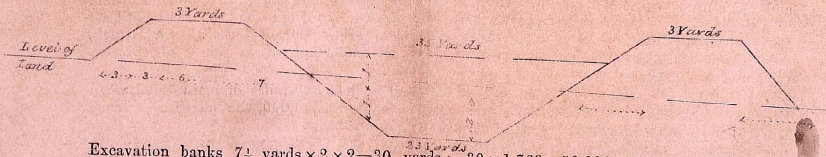
The longitudinal and cross-section of the canal might be then as shown here —





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This would give a canal 35 yards broad at the top, and 23 yards at the bottom.

In such a canal the water in it would be $4\frac{1}{2}$ feet above high-water, and $13\frac{1}{2}$ above low-water, or the average lift, if the engine was worked throughout the day, 9 feet. If the locks were 150 feet long, 15 feet broad, with an average lift of 9 feet, the contents would be 750 cubic yards of water, weighing at 1,700 lbs per cubic yard, about $1\frac{3}{4}$ million lbs to be raised 9 feet,$=13\frac{1}{2}$ millions 1 foot, or about 8 Indicator H. P. 1 hour, or three nominal H. P. 1 hour; and the cost would be at 3 lbs. of coal per I. H. P. at Rs. 10 per ton, $\frac{1}{3}d.$, or adding for management, &c., about half per I. H. P. per hour. This would give $4d.$ per lockfull. Locks of this size would pass boats of at least 200 tons, and if the canal were 50 miles long from one creek to another, 10,000 tons would be carried 1 mile for every lockfull, so that the cost for supplying the lockage would be $\frac{1}{2500}d.$ per ton per mile, in fact, insignificant.

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This also would be quite insignificant, the two together being only $\frac{1}{1000}d.$

We arrive, therefore, at this remarkable conclusion, that the cost of raising the water is in effect nothing, leaving us to cut the canal on any level that will give a minimum excavation. And even if the water had to be raised 50 feet out of deep rivers or wells, it would still be only $\frac{1}{280}d.$ per ton per mile.

It may be asked,—but what about absorption? To this I reply that, in these alluvial soils, there would be none at all; but even if it were very considerable and permanently so, even an inch a day, it would still only raise the cost to $\frac{1}{400}d.$ The cost of locks on such a canal would be, at £ 200 per foot of lift, $13\frac{1}{2} \times 200 =$ £ 2,700, or £ 5,400 for one at each end, adding £ 100 per mile. If we allow 50 yards of aqueduct for crossing small creeks or streams in the 50 miles at £ 100 per yard of length, this would add £ 100 per mile, and the estimate would then be per mile—

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The returns on such a canal on an important line in the neighbourhood of Calcutta, allowing only 1 million tons and passengers, or 500,000 of the former at $\frac{1}{8}d.$, and the same of the latter (1,600 passengers per day) at $\frac{1}{16}d.$, would be £ 380 per annum, or 65 per cent. on £ 560 a mile. But on the main line connecting Calcutta with the Ganges, the traffic would be at least 2 millions for the tonnage of boats alone entering the Circular Canal, several years ago was 3 millions tons, and of course the same boats left it, and this is besides all that discharged and loaded in the Hooghly.

And this plan is equally applicable to the upper plains of the Ganges, because the cost of raising is so small, that even the ground is 40 feet above the summer level of the river, it would still be an insignificant item.

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On any line in which so wide a canal as the above sections show was not required, a considerably less section and excavation would be sufficient, as it might be made deeper and narrower, and the embankments lower; for instance, $1\frac{1}{2}$ yard of the depth of water might be carried below the surface of the land, and of $\frac{1}{2}$ yard above, making the embankments only $1\frac{1}{2}$ yard high, with a section of only 9 square yards each, costing only £ 200 a mile for excavation

OBSERVATIONS.—The Governor General in Council is disposed to mistrust the sufficiency of Sir Arthur Cotton's estimate, not only as to first cost of excavation of the canal and provision of locks, but also as to probable cost of pumping, and amount of traffic and consequent returns.

2. His Excellency in Council considers, however, that it may be useful to circulate the papers to the various Local Governments and Administrations, with a request that when any project is under consideration, and of which the conditions may be similar to those described by Sir Arthur Cotton, the Executive Engineer may be directed to ascertain to what extent the system can be applied with advantage to that particular case, the data on which the conclusions are drawn in favour of the ordinary or proposed system being fully explained.

ORDER.—Ordered, that copies of this Resolution be forwarded to the Local Governments and Administrations marginally noted, for information and guidance.

Governments of Madras, Bombay, Bengal, North Western Provinces, and the Punjab.
Chief Commissioners of Oudh, British Burmah, Central Provinces, and Mysore and Coorg.
Resident at Hyderabad.
Agents to the Governor General for Central India and Rajpootana.

(Signed) R. STRACHEY, *Colonel, R. E.,*
Offg. Secy. to the Govt. of India.

J. Alexander, C. E.,
Asstt. Secy. to the Govt. of India.

To The Secy to the Govt of Madras
P. W. Department

3. Copies –

P.W. 1869 Dept

(2) No. 2454

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

CIVIL WORKS.
Communications.

CIRCULAR TO THE GOVERNMENTS OF MADRAS, BOMBAY, BENGAL, THE NORTH WESTERN PROVINCES, AND THE PUNJAB; THE CHIEF COMMISSIONERS OF OUDH, BRITISH BURMAH, CENTRAL PROVINCES, AND MYSORE AND COORG; THE RESIDENT AT HYDERABAD; AND THE AGENTS TO THE GOVERNOR GENERAL FOR CENTRAL INDIA AND RAJPOOTANA

No. 33 PUBLIC WORKS.

Dated SIMLA, *May* 12, 1869.

Received June 12th/69.

No 2154 - 3rd July 1869 -

Sir A. Cotton's plan for the construction of Steam-boat Canals; the water for lockage and evaporation being raised by Steam-power.

P. W. D. Press—26-5-69.—600.

13

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Govt. of {1869} Madras.

PUBLIC WORKS.

To The Chief Engr. for Irrigation

Dated

Recd. Encl.

G. O. 3rd July 1869, No. 2154

Nos. 53-54

Steam-boat-Canals Circular from the Govt of India relative to Sir A. Cotton's plans for the construction of Steam-boat-Canals, the water for lockage and evaporation being raised by Steam-power. Cird to the Offrs concerned.